

[0021] In the interest of clarity, not all of the standard hardware and routine features of the implementations described herein are shown and described. It will, of course, be appreciated that in the development of any such actual implementation, numerous implementation-specific decisions must be made in order to achieve the developer's specific goals, such as compliance with application- and business-related constraints, and that these specific goals will vary from one implementation to another and from one developer to another. Moreover, it will be appreciated that such a development effort might be complex and time-consuming, but would nevertheless be a routine undertaking of engineering for those of ordinary skill in the art having the benefit of this disclosure.

[0022] The present invention discloses an electronic interactive device having a haptic enabled flexible touch sensitive surface. Haptic feedback can also be referred to as tactile effect, tactile feedback, haptic effect, force feedback, or vibrotactile feedback. In one embodiment, the electronic interactive device includes a flexible touch sensitive surface, a flexible screen (or display), and an actuator. By flexible it is meant that gross deformations are possible with the touch panel as opposed to slight flexures that occur in current touch screens. The flexible screen, for example, can be a rollable display, a foldable display, or a bendable display. A rollable display is a case where a bendable display is capable of bending back on itself to form a roll. The flexible touch sensitive surface can also be a flexible touch panel, a flexible touch sensitive pad, a flexible touch keyboard, or a flexible touch display. The surface of flexible touch sensitive surface is divided into multiple regions wherein each region is capable of sensing a touch or contact on the region by a user. Alternatively, the surface of flexible touch sensitive surface is a continuous borderless input screen with fine input resolution.

[0023] The flexible touch sensitive surface generates an input in accordance with the particular region, which senses the touch, and the graphic displaying content that the user "touches". The actuator, which can be a flexible actuator, is configured to provide haptic feedback in response to the input. In another embodiment, the electronic interactive device also includes a flexible battery and a flexible chip. The flexible battery or power supply is used for supplying power to the device while the flexible chip is used for processing data.

[0024] Turning now to the figures, FIG. 1A illustrates an electronic interactive device 100 having a rollable flexible screen and a haptic enabled flexible touch sensitive surface in accordance with one embodiment of the present invention. Interactive device 100 includes a flexible or a rollable screen having an open portion 102 and a rolled-up portion 103. In one embodiment, open portion 102 is configured to have a display window for displaying images 108. Rolled-up portion 103, on the other hand, is configured to be inactive for conserving power. In an alternative embodiment, open portion 102 is configured to be opaque, which is capable of providing haptic feedback in response to an input.

[0025] In another embodiment, the display window extends to the entire flexible screen including both open portion 102 and rolled-up portion 103 although rolled-up portion 103 usually can not be viewed and/or touched. In other words, the display window does not change regardless of the flexible position or status of the rollable display. The flexible position or status indicates the flexible condition of the rollable display

in which it identifies whether the display is in a rolled-up condition, in a partially rolled-up condition, and so forth. It should be noted that the rollable display could be an electronic paper, an e-paper, a digital paper, an electronic ink, or a power paper.

[0026] A rollable display is an electronic display capable of displaying images and the display can be rolled up into a tube or a scroll. The rollable display is designed to mimic the appearance and the physical properties of regular paper. Unlike a conventional display, the rollable display looks and acts like an ordinary sheet of paper, and it is capable of holding displaying images for a long period of time with limited or no power consumption. The shape of the rollable display may be changed from a planar (or flat) to a rolled up (or a tube) shape. An advantage of the rollable display (such as electronic paper) is lightweight, durable, and flexible.

[0027] An example of rollable display, which can be employed in the present invention, is a Gyricon™ sheet, which is a type of electronic paper developed at the Xerox PARC™ (Palo Alto Research Center). The Gyricon™ sheet has similar physical properties as a traditional sheet of paper except that it can be rewritten many times. The Gyricon™ technology is essentially a technique of manipulating millions of small toner particles in a thin layer of transparent plastic wherein the toner particles are arranged in response to an application of voltage patterns. The image displayed by the Gyricon™ sheet will be maintained until new voltage patterns are applied. It should be noted that other flexible display technologies for manufacturing rollable displays may be available, such as organic light-emitting diode (OLED) and/or organic/polymer TFT (Thin Film Transistor), which may be used to manufacture flexible displays.

[0028] Referring back to FIG. 1A, the flexible touch sensitive surface is deposited over the rollable display thereby a user can use his or her fingertips to contact a region of the flexible touch sensitive surface to emulate a button press according to the graphics displayed behind the region on the flexible display device. In one embodiment, the flexible touch sensitive surface is further configured to dynamically adjust effective touch sensitive surface 110 in accordance with the displaying window of the rollable display. In order for a user to correctly touch an intended region on effective touch sensitive surface 110, the user needs to see the graphics displayed behind the region from the rollable display. As such, matching the size of effective touch sensitive surface 110 to the display window is, in one embodiment, desirable.

[0029] The flexible touch sensitive surface is further configured to divide its touchable or contactable area into multiple regions 111-126 separated by borders 130. Each region of the flexible touch sensitive surface is used to accept an input when a region is touched or pressed by a user. Conversely, the flexible touch sensitive surface rejects a user's input when a border 130 is touched.

[0030] The flexible position or status of the rollable display, in one embodiment, identifies the rollable status of a rollable flexible screen in real-time since a user may continuously fold or unfold the flexible display just as, for example, folding or unfolding a page of newspaper. The size of effective touch sensitive surface 110 is adjusted by activating and/or deactivating regions in accordance with the value of flexible position. In other words, the flexible position identifies what percent of the display is rolled up and what percent of display is open. Flexible position is used to determine the actual size of display window and effective touch sensitive surface 110.